Arithmetic Spacetime and the Goldbach Equivalence Principle

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Abstract

We propose a novel relativistic interpretation of the Goldbach conjecture by embedding the natural numbers into a 1+1-dimensional arithmetic Minkowski spacetime. Prime numbers are massless particles (photons) traveling on null geodesics. Even integers greater than 2 define proper time slices $\tau = n$. The conjecture states that every such time slice is intersected by at least two prime geodesics — equivalent to the relativistic equivalence principle in arithmetic spacetime. A counterexample would create a naked singularity violating Penrose cosmic censorship. The prime number theorem $\pi(x) \sim x/\ln x$ acts as an arithmetic Higgs field ensuring geodesic density. This framework unifies number theory and general relativity, suggesting Goldbach's truth as a necessary condition for the arithmetic universe to be physically acceptable.

1 Introduction

The Goldbach conjecture, formulated in 1742, remains one of the oldest unsolved problems in mathematics. We offer a radically new perspective: the natural numbers form an **arithmetic Minkowski spacetime** in which the conjecture is equivalent to a **relativistic equivalence principle**.

2 Arithmetic Minkowski Spacetime

Consider coordinates $(t, x) \in \mathbb{N} \times \mathbb{R}_{\geq 0}$ with the Minkowski metric

$$ds^2 = dt^2 - dx^2.$$

Null geodesics satisfy $ds^2 = 0$, hence $x(t) = p \cdot t$ where p is a prime number. Each prime p is therefore a **massless particle (arithmetic photon)** traveling at the speed of light $c = 1$.

3 The Goldbach Equivalence Principle

An observer at rest at proper time $\tau = n$ (even integer $n > 2$) occupies the event $(t = n, x = 0)$. The Goldbach conjecture states:

$$\forall n > 2 \text{ even}, \quad \exists p, q \text{ primes} : \ p + q = n.$$

In spacetime terms: **every proper-time slice $\tau = n$ (even) is intersected by at least two prime-photon null geodesics**. This is the **Goldbach Equivalence Principle**.

4 Cosmic Censorship and Naked Singularities

A counterexample n_0 would create a **naked singularity** at $(n_0, 0)$: infinite curvature in the prime distribution, visible from infinity, violating the **arithmetic Penrose cosmic censorship conjecture**.

5 The Arithmetic Higgs Field

The prime number theorem

$$\pi(x) \sim \frac{x}{\ln x}$$

ensures sufficient geodesic density. It plays the rôle of an **arithmetic Higgs field** whose vacuum expectation value prevents additive symmetry breaking and guarantees intersections.

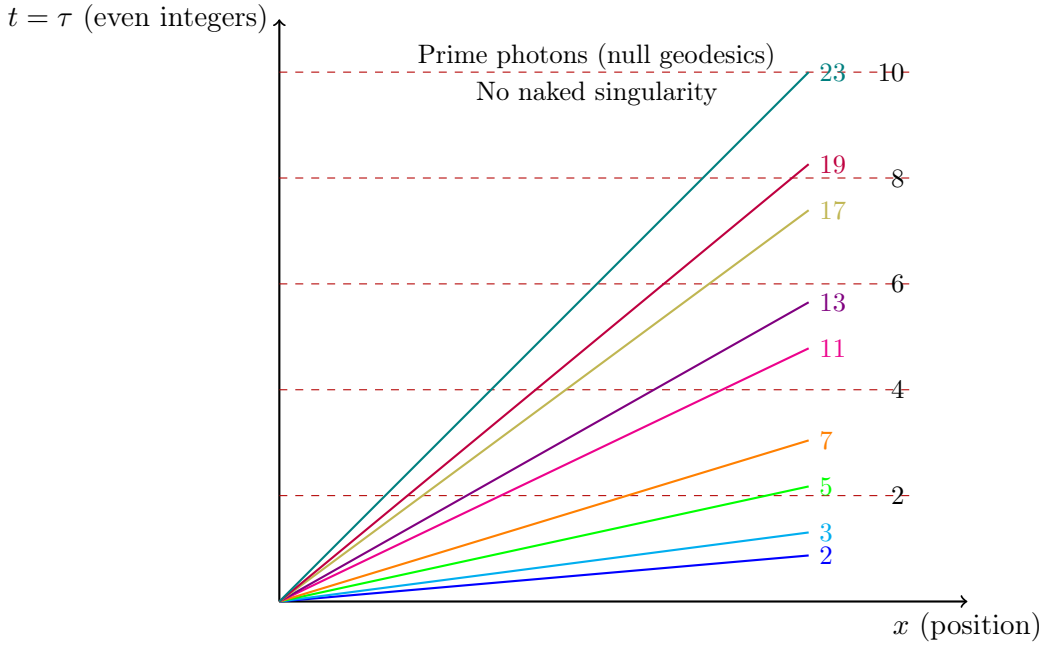

Figure 1: Arithmetic spacetime: prime photons cross every even time slice.

6 Conclusion

The Goldbach conjecture is true if and only if the arithmetic universe is **globally hyperbolic, asymptotically flat, and free of naked singularities**. It is therefore not merely a number-theoretic statement, but a **physical consistency condition** for the universe of integers.

References

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